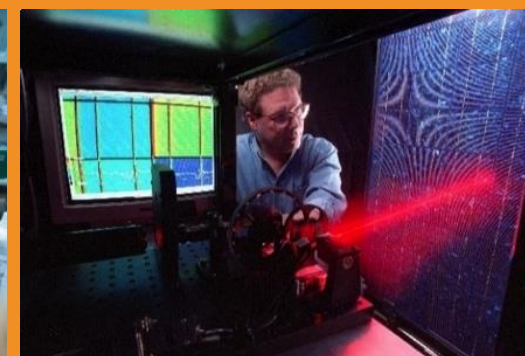




Office of ENERGY EFFICIENCY
& RENEWABLE ENERGY

SOLAR ENERGY TECHNOLOGIES OFFICE



Solar Energy Technologies Office: Opportunity Showcase

For students and faculty of Historically Black Colleges and Universities

Garrett Nilsen, Christie L.C. Ellis, Andru Prescod, Abigail
Randall, Zach Eldredge, Jamal Ferguson

April 22, 2021

energy.gov/solar-office

Housekeeping and Logistics

- This session is being recorded and will be made available on energy.gov/solar-office
- We will take questions at the end – put these in the chat
- We appreciate if you can take our [feedback survey](#) at the end about how we can continue to engage with you
- This session will be followed up by a [session](#) with all the Energy Efficiency and Renewable Energy (EERE) technology offices on April 27 from 2-4 p.m. ET

Solar Energy Technologies Office (SETO) Mission

MISSION

We accelerate the **advancement** and **deployment of solar technology** in support of an **equitable** transition to a **decarbonized energy system by 2050**, starting with a decarbonized power sector by 2035

WHAT WE DO

Advance solar technology and drive soft cost reduction to make solar **affordable** and **accessible** for all Americans

Enable solar to **support grid reliability** and pair with storage to provide new options for **community resilience**

Support **job growth**, **manufacturing**, and the **circular economy** in a wide range of applications



Driving Toward Biden Decarbonization Goals

- ▶ **Accelerate solar deployment and associated job growth** by opening new markets, providing workforce training, and growing U.S. manufacturing.
- ▶ Enable inverter-based technologies to provide essential grid services and black start capabilities while demonstrating the **reliable, resilient and secure operation of a 100% clean energy grid**.
- ▶ **Reduce hardware and soft costs** of solar electricity for all Americans to enable an affordable carbon-free power sector by 2035.
- ▶ **Support a decarbonized industrial sector** with advanced concentrating solar-thermal technologies and develop affordable renewable fuels produced by solar energy.
- ▶ **Center energy justice** by reducing environmental impacts, removing barriers to equitable solar access, and supporting a diverse and inclusive workforce.

The seal of the United States Department of Energy is a circular emblem. It features a blue outer ring with the text "DEPARTMENT OF ENERGY" at the top and "UNITED STATES OF AMERICA" at the bottom in gold. The center is a shield with a green background. On the shield, there is a white eagle at the top, a yellow sun, a yellow lightning bolt, a yellow gear, and a yellow oil derrick. The shield is set against a white background.



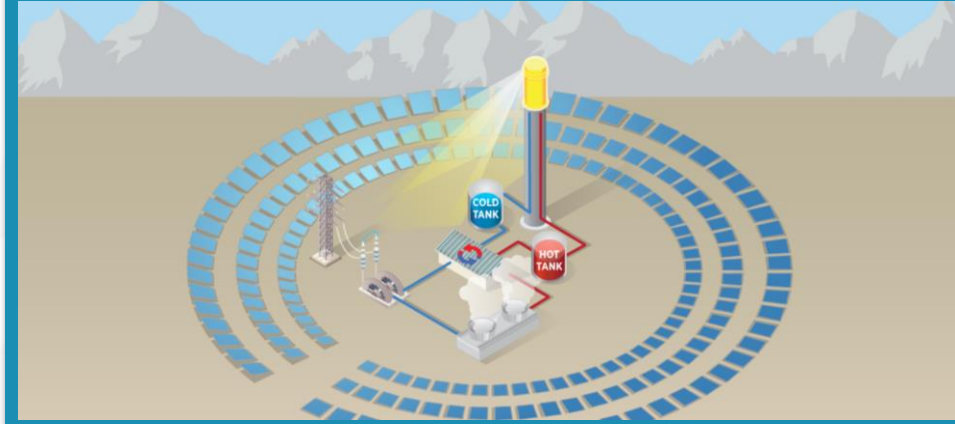
Updated 1/20/2021

SETO Teams

PHOTOVOLTAICS



CONCENTRATING SOLAR-THERMAL POWER



STRATEGIC ANALYSIS AND INSTITUTIONAL SUPPORT



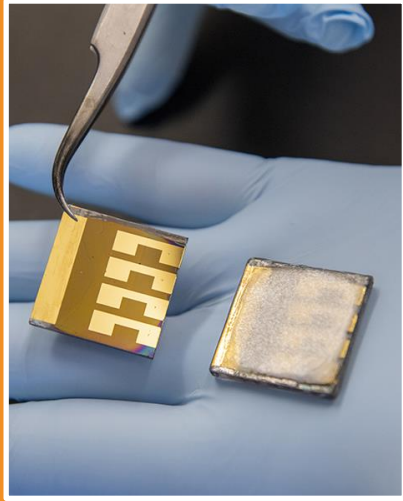
SYSTEMS INTEGRATION



MANUFACTURING AND COMPETITIVENESS



Solar Power System Sizes



Lab-scale
Solar Devices



Rooftop and
Commercial
Solar



Microgrids and
Community
Solar



Utility-Scale
Solar

Milliwatts

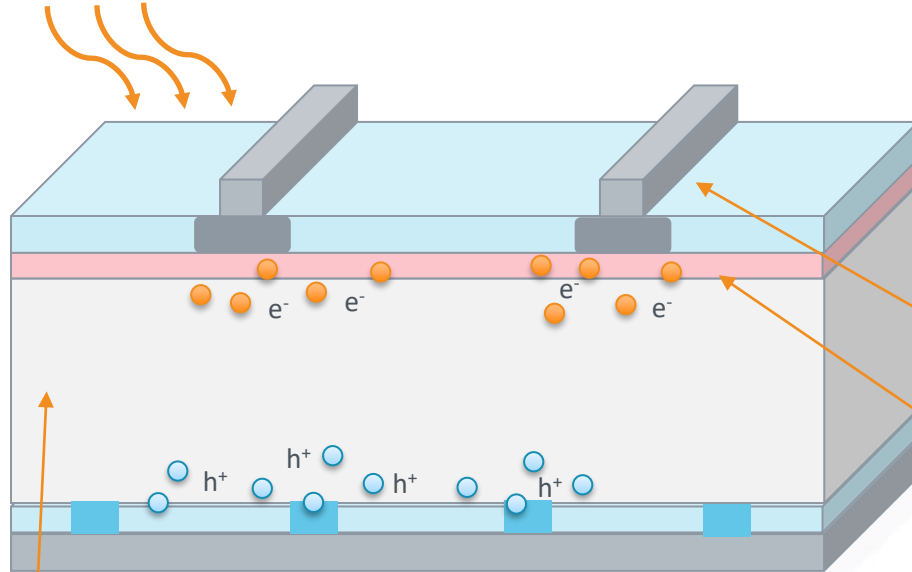
Kilowatts

Megawatts

Gigawatts

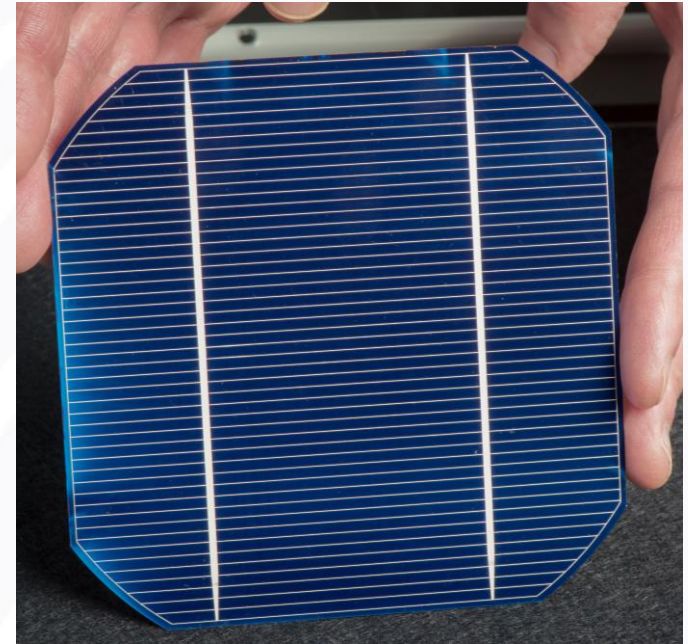
Photovoltaic (PV) System Basics

Sunlight



The **Absorber** absorbs sunlight and creates large numbers of excited electrons.

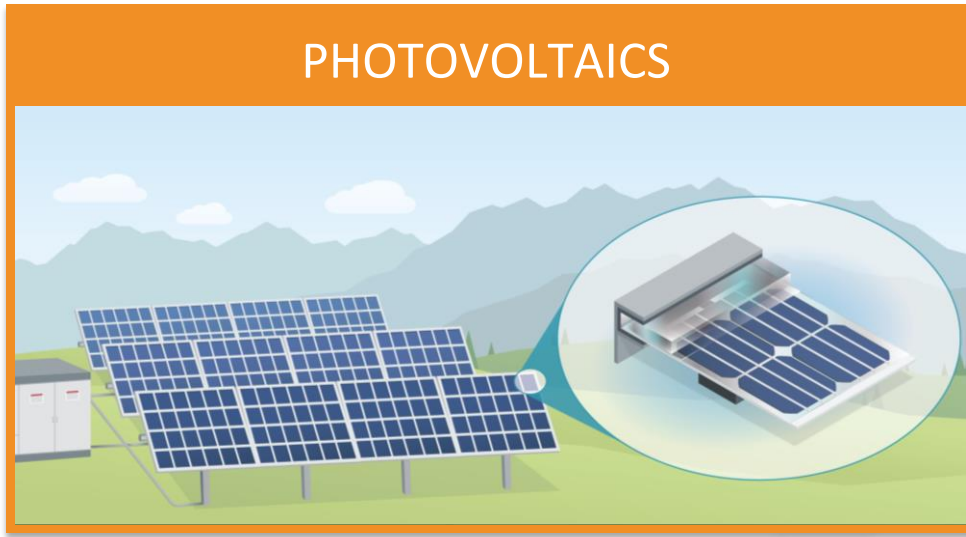
Roughly 95% of solar cells use **Silicon** as their absorber material.



The **Junction** and **Contacts** force the excited electrons to move in the same direction.

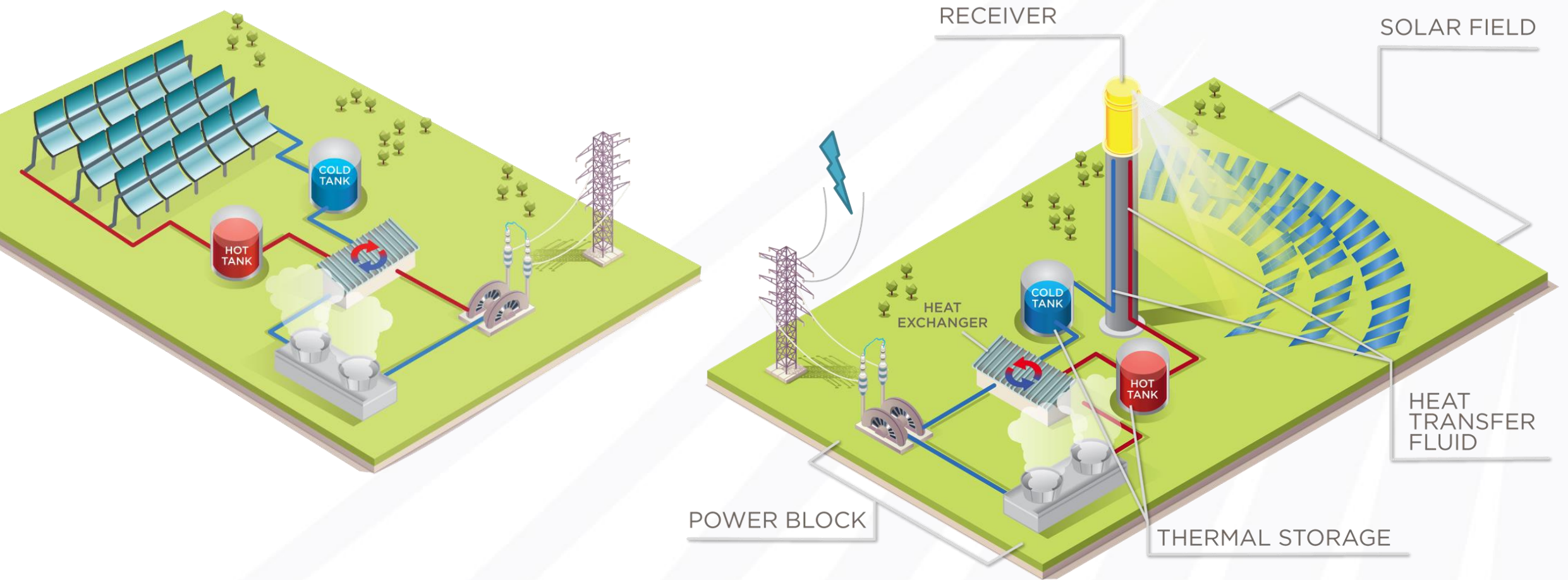
This creates useable current and voltage, which together make up **electrical power**.

Photovoltaics Team: Common Majors



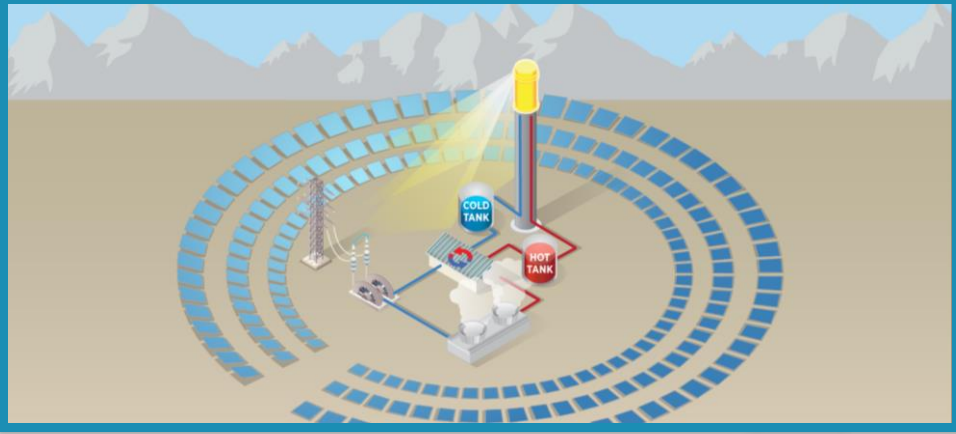
- Chemistry
- Physics
- Chemical Engineering
- Materials Science and Engineering
- Mechanical Engineering
- Electrical Engineering
- Computer Science

Concentrating Solar Thermal Power Basics



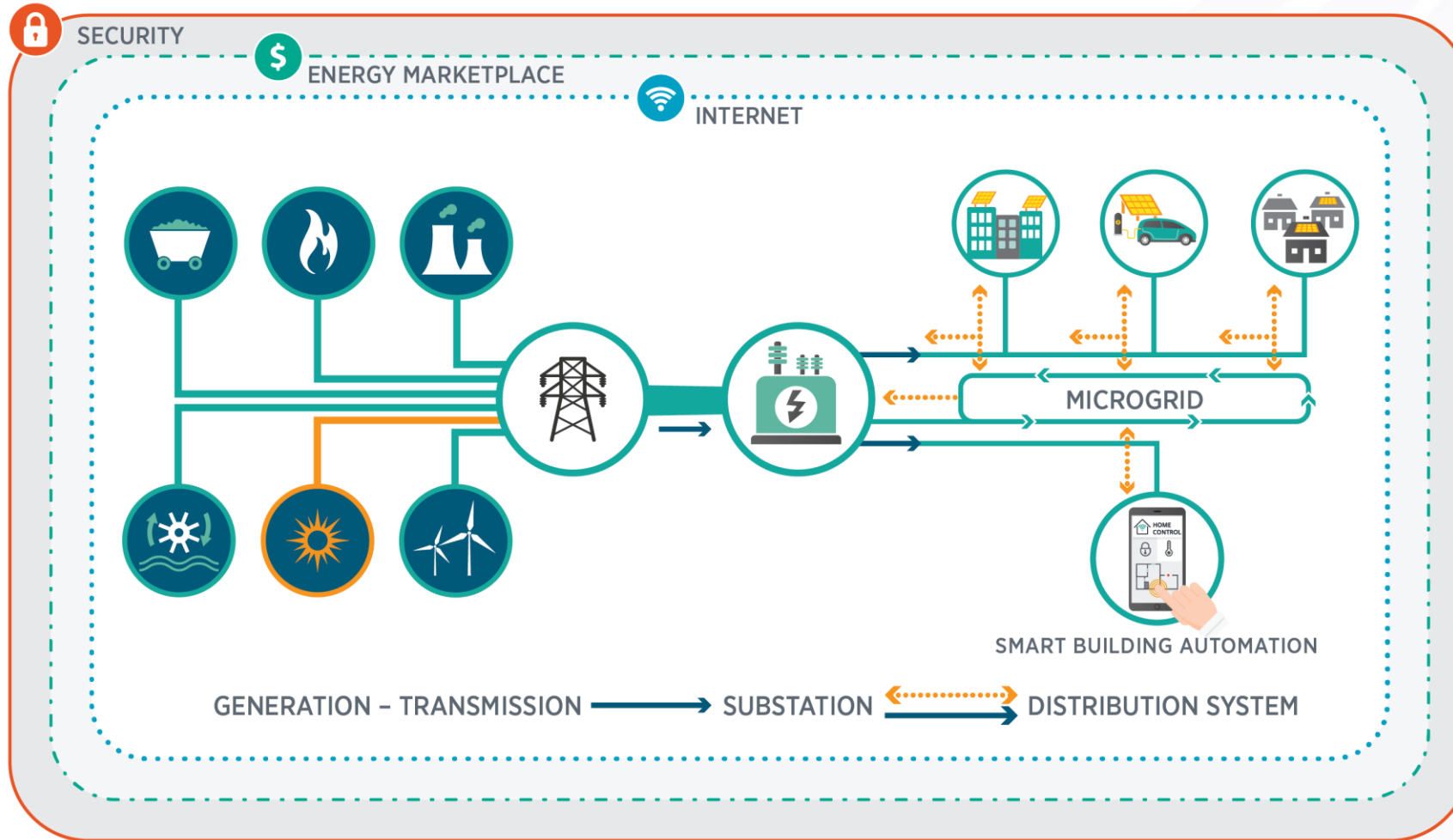
Concentrating Solar-Thermal Power Team: Common Majors

CONCENTRATING SOLAR-THERMAL POWER



- Chemistry
- Physics
- Chemical Engineering
- Materials Science and Engineering
- Mechanical Engineering
- Electrical Engineering (Optical Sciences)

Systems Integration Basics



Solar Forecasting

Grid Planning and
Operation

Power Electronics

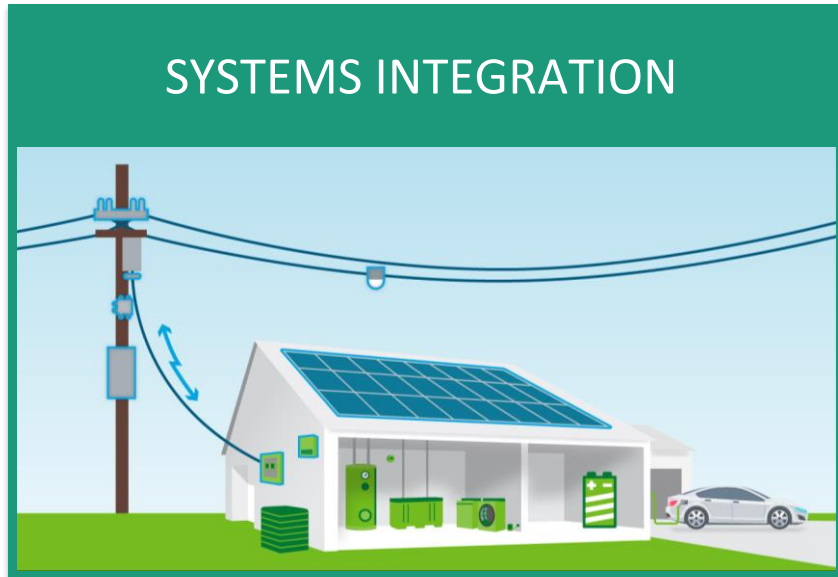
Integration with Energy
Storage

Codes and Standards

Sensors and
Communications

Grid Integration
Analysis

Systems Integration Team: Common Majors



- Electrical Engineering
- Mechanical Engineering
- Industrial Engineering
- Systems Engineering
- Physical Sciences
- Mathematics/ Statistics/ Data Science
- Computer Science

Manufacturing and Competitiveness

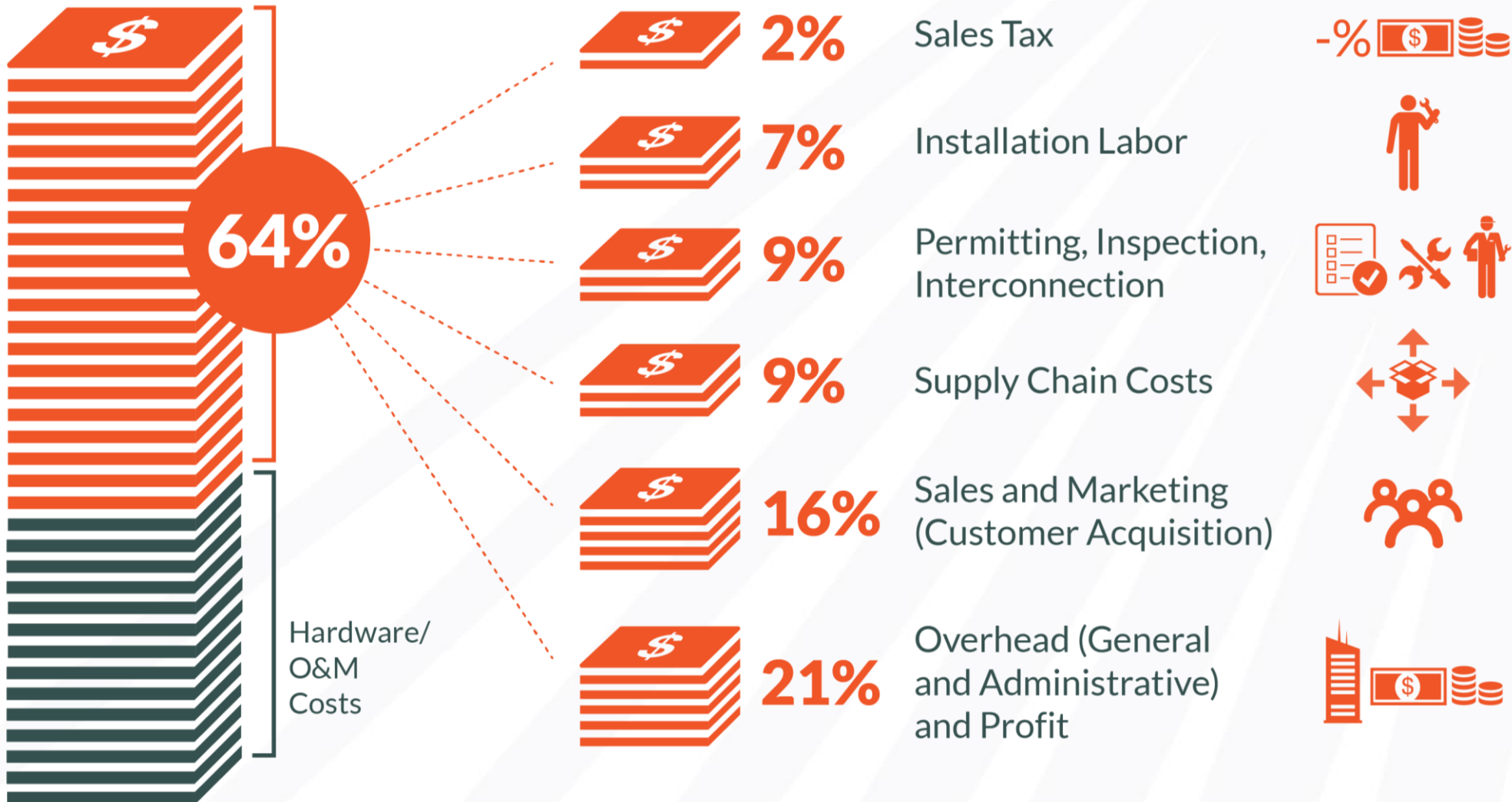


Manufacturing and Competitiveness Team: Common Majors



- Economics
- Business
- Entrepreneurship
- Mechanical Engineering
- Chemical Engineering
- Electrical Engineering
- Materials Science and Engineering

Solar Soft Costs



Source: National Renewable Energy Laboratory "U.S. Solar Photovoltaic System and Energy Storage Cost Benchmark: Q1 2020."

Strategic Analysis and Institutional Support Team: Common Majors

STRATEGIC ANALYSIS AND INSTITUTIONAL SUPPORT



- Public Policy
- Behavioral Science
- Economics
- Environmental Science
- Mathematics/ Statistics/ Data Science
- Physics
- Systems Engineering

SETO's Role

Early-Stage Research Investments

- PV, CSP, and grid integration R&D with a history of commercial impact
- Pre-competitive R&D, typically 10-20 years from the market, is beyond the private-sector horizon

Mid-Stage Development Investments

- Topics include reliability and open-access performance data not addressed by the private sector
- Public-private partnerships to support the next generation of innovative solar products

Energy System Planning

- In-depth technical studies and modeling solar's impact on the national grid
- Unique facilities for RD&D at the national laboratories (e.g.the Energy Systems Integration Facility)

Regional/National Scope Technical Analysis

- National labs provide tools and trusted, impartial information
- Leadership in data standardization and best practices

Expanding Consumer Choice

- Efforts to streamline solar deployment taking root with co-ops and utilities
- Programmatic efforts to expand household solar access to all Americans

DOE Solar Office Funds 375+ Active Projects

Projects and partners in **47** states plus the **District of Columbia**

40% of projects led by
national labs



30% of projects
led by **universities**

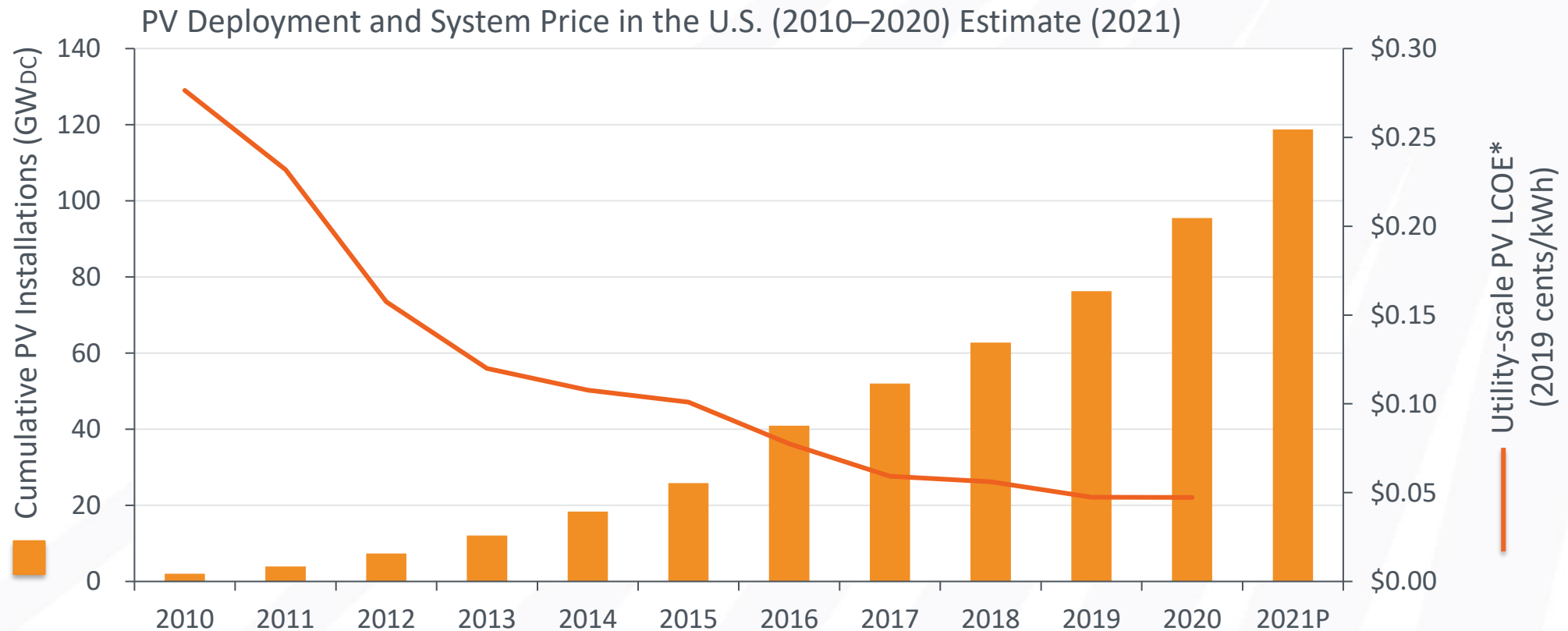


30% of projects led by
**businesses, non-profits, and
state and local government**



U.S. Solar: Falling Costs, Rising Deployment

The solar energy industry is one of the fastest growing industries in the nation. Driven by falling costs and state and federal policy, total solar PV installed capacity is now **95 GW** and is **projected to grow to 118 GW** by the end of the year.

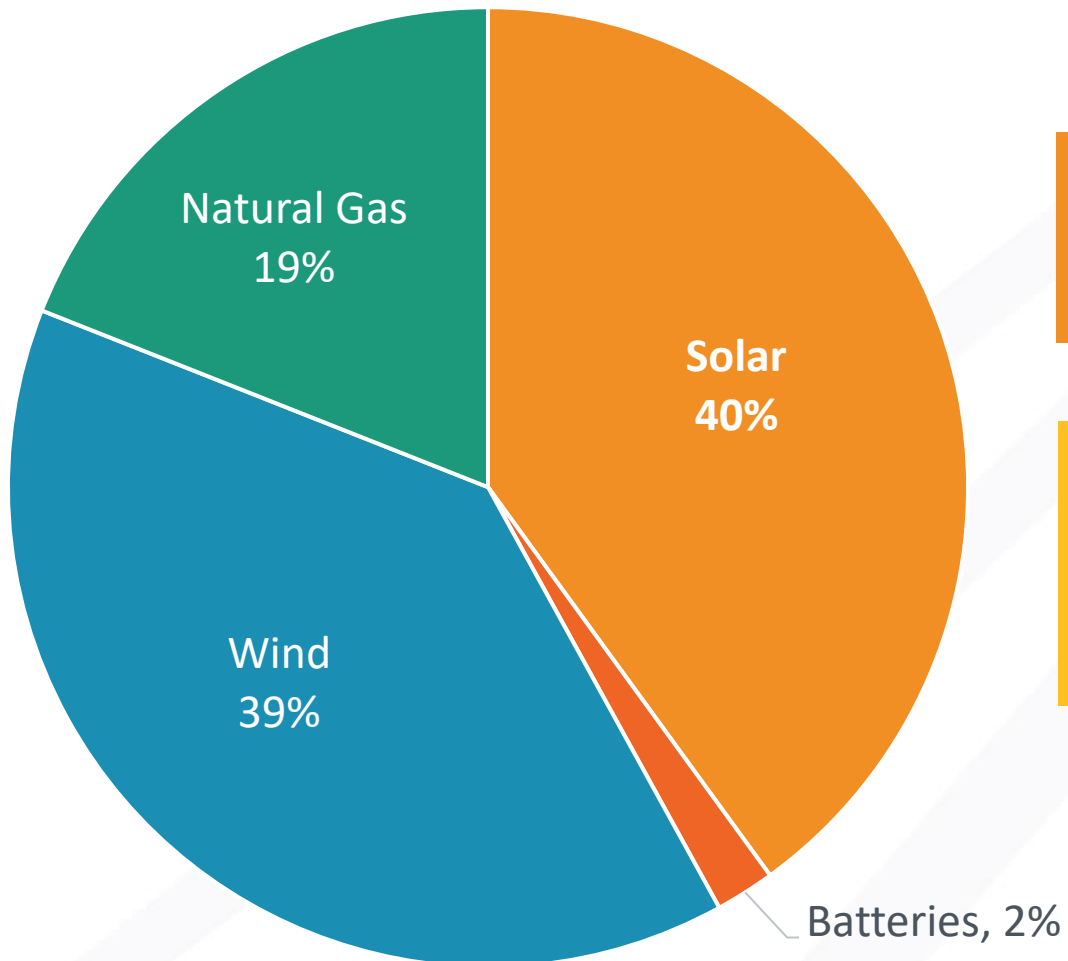


*Price is depicted as levelized cost of energy (LCOE)

Sources: National Renewable Energy Laboratory, "U.S. Solar Photovoltaic System Cost Benchmark: Q1 2019"; Wood Mackenzie Power & Renewables/SEIA U.S. Solar Market Insight.

Solar is One of the Fastest Growing Energy Sources in America

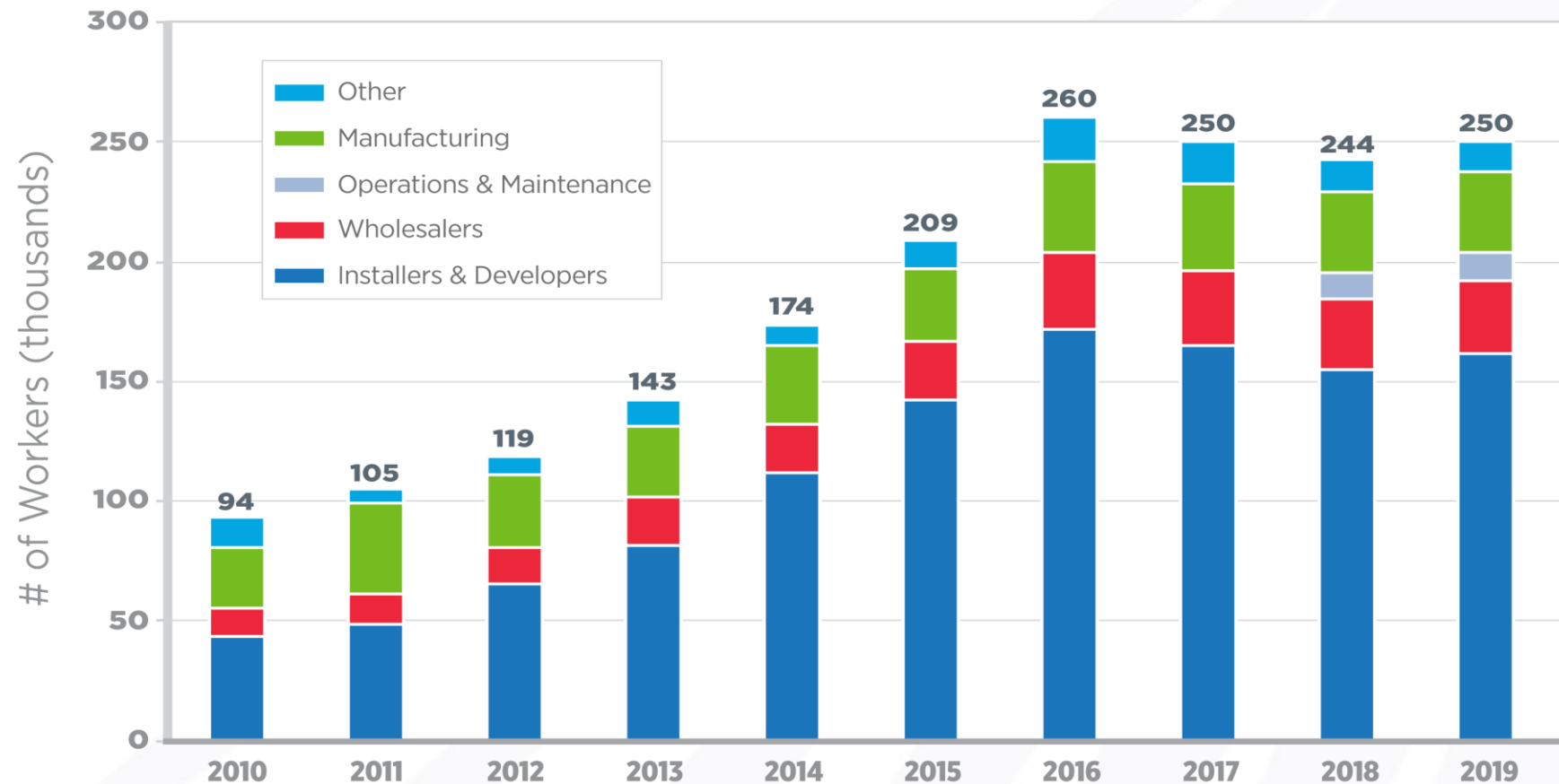
New Capacity in 2020



In 2020, solar PV represented **40%** of all new electricity capacity installed in the United States.

Solar energy represented **33%** of new capacity additions **over the past 5 years** and now supplies over 3% of the nation's annual U.S. electricity.

250,000+ U.S. Jobs in the Solar Industry



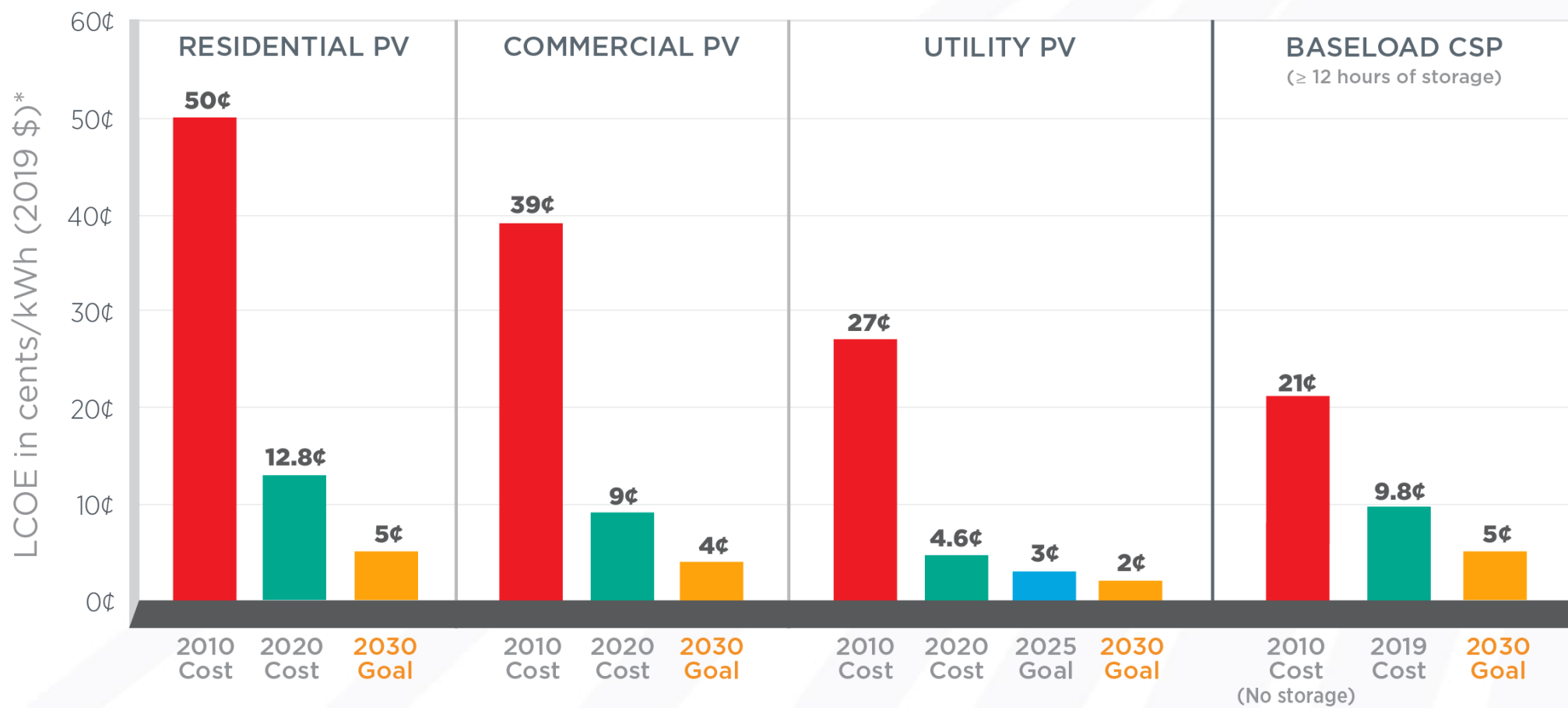
- Since 2010, solar employment **has grown by 159%**
- The median wage for solar installers is **\$24 per hour**, increasing to **\$32 per hour** for supervisors or foremen

- **9x** national job growth rate in the last 5 years
- **Manufacturing** is the **2nd** largest sector in the solar industry, growing **48%** since 2010

Source: The Solar Foundation, "2018 National Solar Jobs Census."
energy.gov/solar-office

Continuing Cost Reduction: 2030 Targets

The office invests in innovative research efforts that securely integrate more solar energy into the grid, enhance the use and storage of solar energy, and lower solar electricity costs.



*Levelized cost of energy (LCOE) progress and targets are calculated based on average U.S. climate and without the Investment Tax Credit or state/local incentives.

Capacity & Economic Impact

Solar capacity has grown **35-fold** in the last 10 years. Solar energy accounted for **40% of all new electrical** generating capacity installed in 2020.



10,000+

Solar businesses in the U.S.



\$24 billion

Value of the U.S. solar market in 2020



45% ↓

Solar PV prices have dropped almost in half over the last 5 years

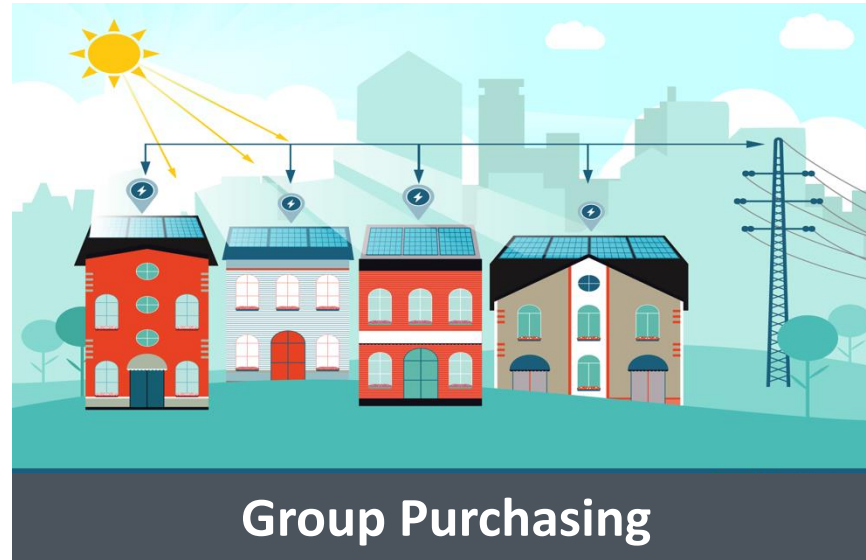
Source: Data from SEIA/Wood Mackenzie Power & Renewables U.S. Solar Market Insight Report

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Opportunities Beyond the Residential Rooftop

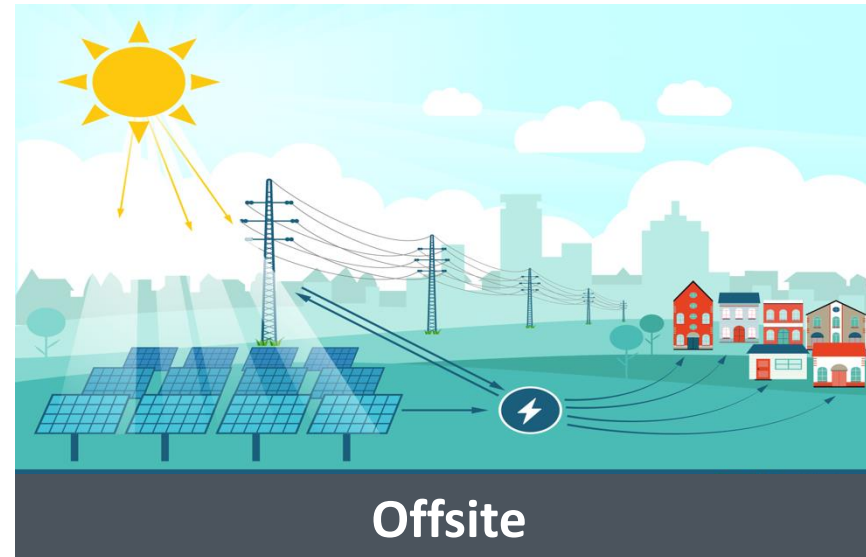
Community Solar

Community members work together to enable solar in their community



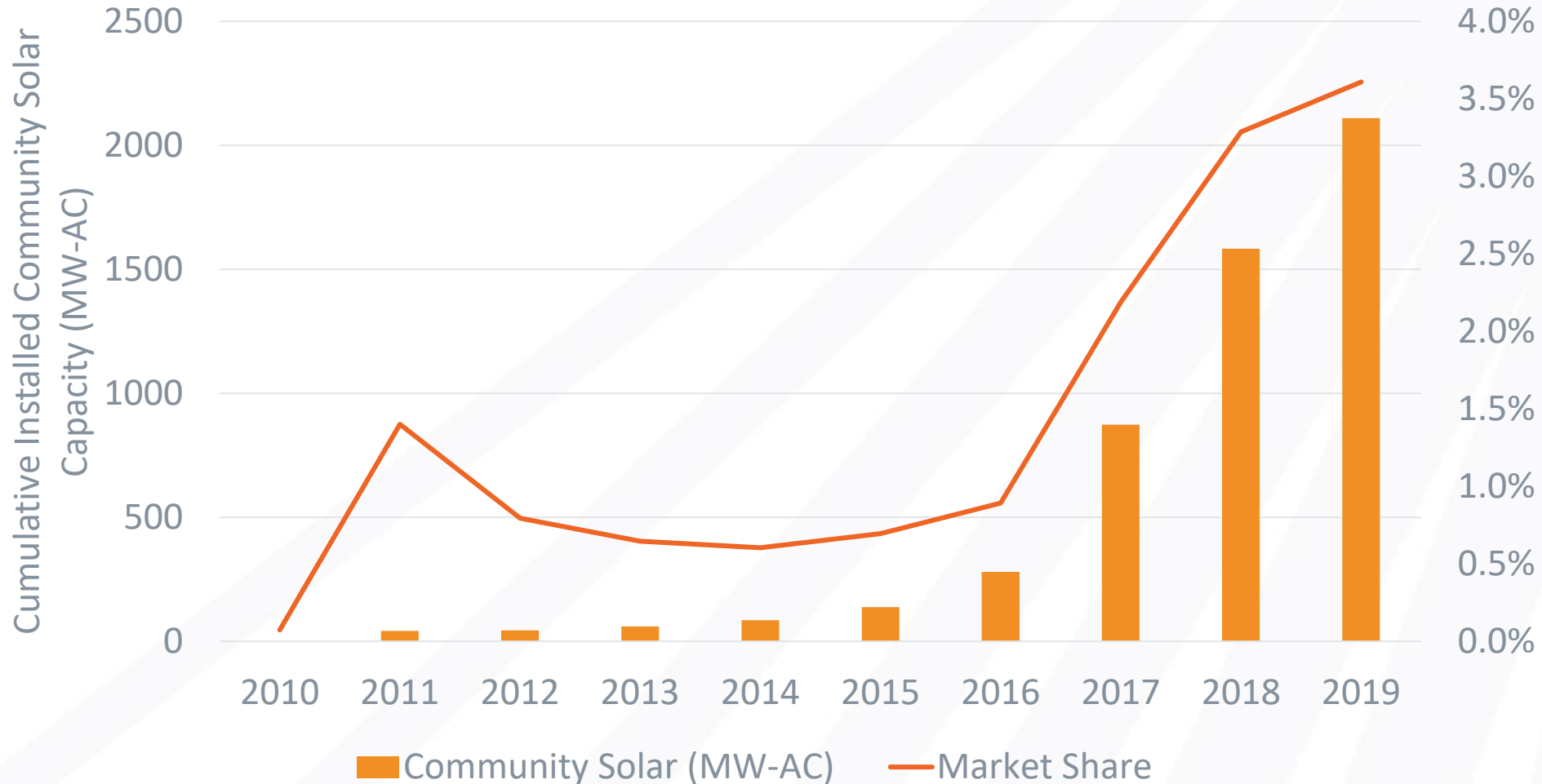
Shared Solar

Participants own or lease panels, buy kWh blocks of generation, or own an interest in a shared system



Supporting an Equitable Transition

Community solar offers a pathway for equitable access to solar for all Americans.



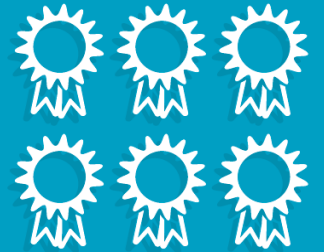
Manufacturing and Competitiveness Portfolio Analysis

152
Small
Businesses



RECEIVED

202
Awards



Over
\$248M
Invested



TURNED INTO

Nearly
\$6.3B of
Follow on Funding



RESULTING IN A



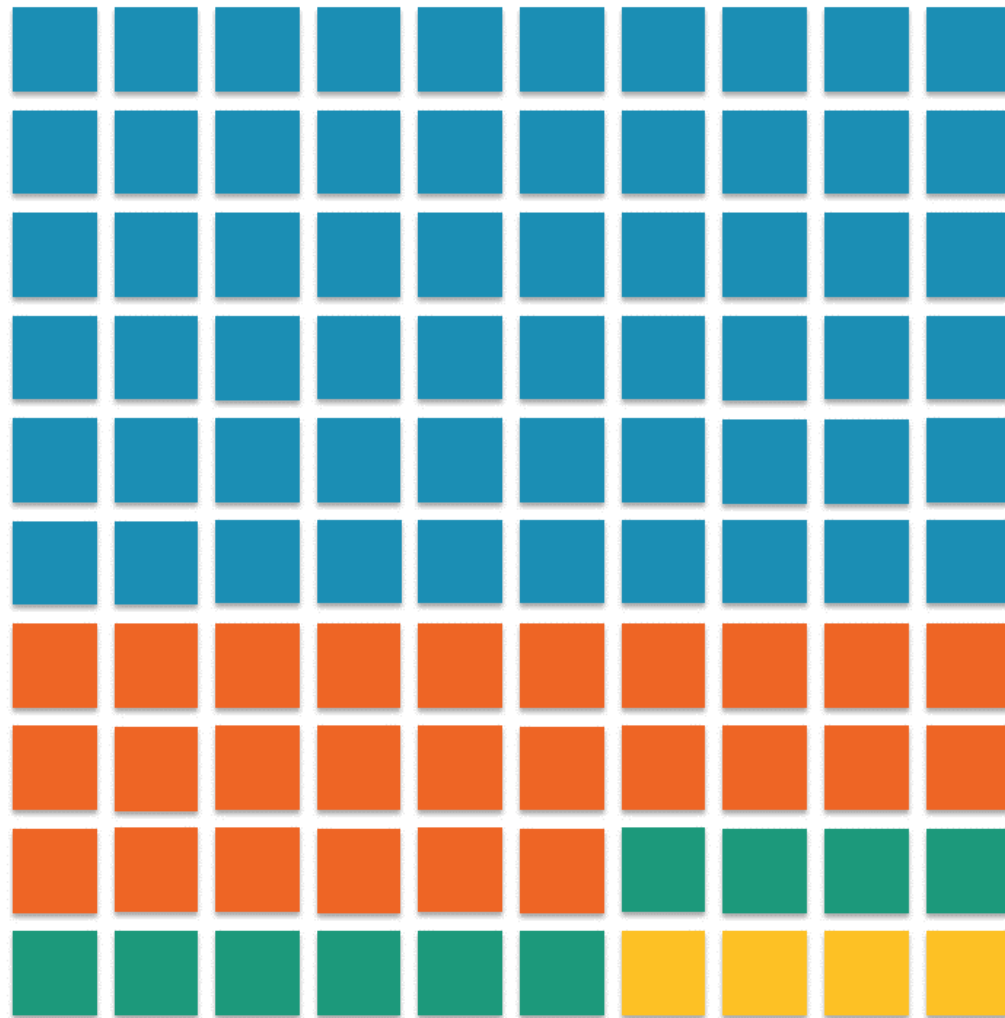
25x
Investment
Multiplier



Solar Solutions for a Clean Energy Future



Primary Competitive Funding Solicitations



Funding Opportunity Announcements
55-70% of SETO funding

Direct National Lab Funding
25-35% of SETO funding

Prizes and Challenges
10% of SETO funding

Small Business Innovation Research (SBIR), Small Business Technology Transfer (STTR)
4% of SETO funding

How does SETO decide which topics to fund?

- Starting point: Multi-year Program Plan
- Research, analysis, and literature
- Congressional and administrative direction
- Workshops, Conferences, and Events
- Peer Review
- Requests for Information (RFIs)
- SETO Staff “Idea-Fests”
- Topics reviewed by DOE leadership and other DOE offices

Funding Restrictions

- SETO cannot:
 - Fund development of policy at a local, state, or federal level
 - Fund advocacy work
 - Fund passive solar or solar hot water projects
 - Purchase solar systems for individuals or other entities
 - Provide loans for solar technology demonstrations
 - Provide grants upon request
 - Seek out entities to fund

Finding Funding Opportunity Announcements (FOAs)

- Subscribe to our newsletter
- Visit the funding opportunity page
- Familiarize with recurring FOAs and cadence of FOA releases
 - Small Business Innovation Research (SBIR) and Technology Commercialization Fund (TCF) – Fall
 - Office-wide FOAs – November-May
 - Prizes – Year-round

Teaming

- To facilitate the formation of new project teams for FOAs, SETO provides a “teaming partner list” to allow potential partners to connect and explore synergies
- Listings include an organization’s contact information, area of technical expertise, and capabilities
- To browse or add your organization to the list, visit [EERE Exchange](#) and find the FOA you are applying for
- SETO cannot compel entities to work as a team or direct specific teams to apply for our funding

Project Selection Criteria

- Technical quality of proposals – impact and ability to execute
- Qualifications of the team
- Appropriate work for government involvement
- Fit in SETO mission space (too early-stage or too mature)
- Overall portfolio diversity
- Diversity, equity, and inclusion plan

FOA Diversity, Equity, and Inclusion Plan

- Newly introduced with the FY2021 Photovoltaics and Concentrating Solar-Thermal Power FOA
- Applicants required to submit a plan describing how they will support underrepresented groups, advance equity, and promote inclusion
- Minority-serving institutions, minority-, woman-, or veteran-owned businesses, or entities from disadvantaged communities are encouraged to apply

Research Areas: Photovoltaics

The goal for SETO's photovoltaics research is to achieve \$0.02/kWh for utility-scale PV with modules at <\$0.02/W, >25% efficiency, and 50-year lifetimes.

Where we are now:

- Module cost: \$0.36/W (\$0.20/W global)
- System LCOE of \$0.045/kWh
- Efficiencies 18-20%, lifetimes 20-30 years
- 95% of global market is silicon PV
- U.S. 2019 utility-scale PV deployment was 37% CdTe

Priority R&D Topics:

- Improved materials, modules, and system construction
- Advancing U.S. technology leadership (CdTe and perovskite PV)
- Enhancing reliability and improving testing procedures
- Managing end-of-life processes



Research Areas: Concentrating Solar-Thermal Power

The goal for SETO's CSP research is to achieve \$0.05/kWh for dispatchable CSP with >12 hours of thermal energy storage (TES), with a 50% thermal-to-electric power cycle efficiency at a turbine inlet temperature of > 700 °C

Where we are now:

- Modeled LCOE of \$0.098/kWh for a U.S. plant with 14 hours of TES
- 1.7 GW CSP deployed in the U.S., 6.4 GW globally
- 5 GW of global deployment is parabolic trough, 1.2 GW is tower
- 45% of global tower capacity and 34% of trough capacity has 6 or more hours of storage

Priority R&D Topics:

- Designing and piloting 'Gen3 CSP' high-temperature (> 700 °C) thermal transport systems
- Lowering the installed cost of highly autonomous heliostats
- Enhancing the performance and reliability of CSP plants
- Developing solar thermal systems and components for solar-driven industrial processes



Research Areas: Systems Integration

The goal for SETO's system integration research is to achieve high-solar grid integration by supporting the reliability of the power system, enhancing resilience and security, and increasing system flexibility to reduce grid integration costs.

Where we are now:

- Inverter-based solar and wind resources pose challenges to system reliability and stability
- Solar generation variability and uncertainties
- System operators have no visibility or control over most distributed solar

Priority R&D Topics:

- Develop long-term planning models and tools for solar integration
- Develop advanced control capabilities for power electronics
- Enhance grid services to operate high-solar grid
- Advance communications and sensing for situation awareness
- Improve solar forecasting
- Integrate storage to add flexibility
- Enhance resilience and security in system design
- Accelerate grid codes and standards development

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Research Areas: Manufacturing and Competitiveness

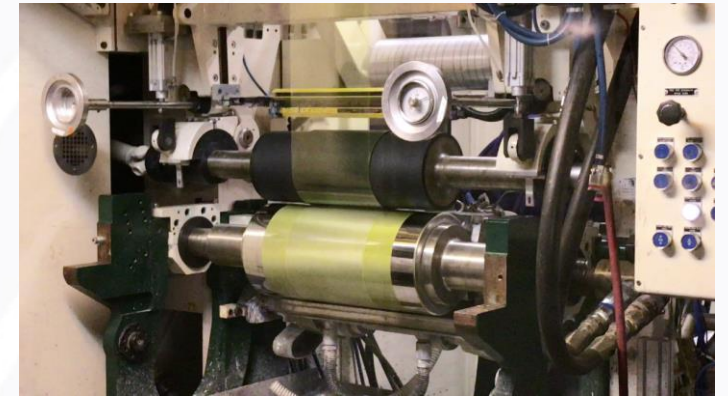
The goals for SETO's Manufacturing and Competitiveness team are to support new technologies commercialization and to support U.S. solar manufacturing capacity increase across the value chain.

Goals:

- 1 GW/year of new U.S. PV manufacturing capacity based on technology that was not yet commercialized in 2020
- The solar hardware installed in the United States has at least 45% domestic value

Activities:

- Support domestic manufacturing of emerging absorbers (perovskite) or materials where the US has already global leadership (CdTe)
- Support technology transfer and accelerate transition of new solar technologies into the market
- Support entrepreneurs and the entrepreneurial ecosystem



Research Areas: Soft Costs

The goals for SETO's soft cost research are to reduce the non-hardware costs of residential, commercial, and utility-scale solar, and to enable 100% of U.S. energy consumers to have access to solar electricity that does not increase their energy costs

Where we are now:

- ~70% of residential and commercial PV solar LCOE are soft costs
- ~40% of utility PV solar LCOE are soft costs
- ~50% of Americans cannot access rooftop solar for technical or financial reasons
- Community solar projects in 39 states and D.C., 74% are in just four states

Priority R&D Topics:

- Lowering permitting, inspection and interconnection costs
- Reducing land use conflicts for solar siting, including co-location of solar and agriculture, wildlife interactions, and environmental impacts
- Removing barriers to community solar
- Removing financing barriers to solar for low-income households
- Improving grid planning for high-penetrations of solar and other DERs
- Improving market transparency of solar adoption trends and data
- Removing barriers to solar in new construction and roof replacements



Research Areas: Workforce

SETO's workforce projects are intended to support the development of a well-trained and diverse solar workforce which reduces soft costs by ensuring that the industry can hire the range of expertise it needs to grow, adopt updated technologies, and develop more efficient practices.

Where we are now:

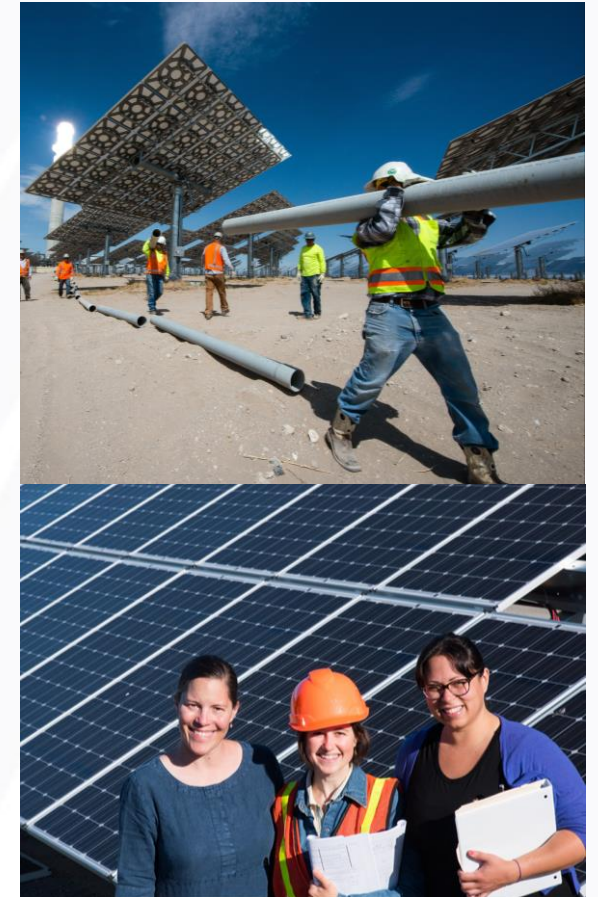
- The solar industry is one of the fastest growing job sectors in the U.S. (167% growth over 10 years) and 1/3rd of solar installers report difficulty hiring new employees
- Minority groups and woman are under-represented in the solar workforce, even as the clean energy industry provides higher wages than the national average.

What we're doing now:

- 7 projects focused on installation training, including the Solar Ready Vets Network
- 3 projects on grid integration and cyber security, including the Solar Collegiate Cup
- 3 awards on training for firefighters, building managers, other peripheral sectors

Priority R&D Topics:

- Support goals to reduce carbon emissions through increased solar deployment
- Ensure equitable representation in the solar workforce
- Provide solar career pathways for veterans
- Support training around new technologies and peripheral industries



Currently Open Opportunities

- **SETO Fiscal Year 2021 PV/CSP Funding Opportunity Announcement**
 - \$39.5M for R&D projects to advance PV/CSP technology
 - Letter of intent due April 26, 2021
- **American-Made Challenges: Perovskite Start-Up Prize**
 - \$3M to accelerate commercialization of perovskite solar cells
 - Applications due June 30, 2021
- **American-Made Challenges: Solar Desalination Prize Round 2**
 - \$5M to develop systems that use solar-thermal energy to purify water
 - [Info webinar](#) on May 4, 2021, 2 p.m. ET
 - Applications due July 15, 2021

Solar District Cup

Prepares students to become leaders in the next generation of distributed solar energy. As competitors, students will:

- Engage with industry leaders and industry professionals to forge mentorships and connections that will aid their transition to the solar energy workforce upon graduation
- Incorporate real-world electricity data and energy-use constraints in the development and design of their energy systems
- Create conceptual physical and electrical layouts, build financial models, perform data analysis, and evaluate for land use, permitting, and other regulations
- Build experience with real-life examples of innovative, integrated renewable energy design in the marketplace
- Compete to win a Solar District Cup division!

Class of 2021 winners will be [announced](#)
on April 26 at 11 a.m. ET



ORISE Science & Technology Policy Fellowship

Establish new projects and initiatives to make solar energy more affordable and reliable and learn about the federal government's role in advancing science and technology.

Design and implement national R&D strategies for:

- Photovoltaic technology
- Concentrating solar power technology
- Solar grid integration technology
- Solar manufacturing and commercialization
- Soft costs of solar adoption

Eligibility:

- Available to physical and social scientists, engineers, and entrepreneurs holding bachelor's, master's, or Ph.D. degrees of all quantitative backgrounds, as well as applicants with relevant post-degree experience.

Benefits:

- One-year appointment, renewable for a second year
- Competitive stipend
- Mentorship from DOE officials
- Travel allowance
- Health insurance supplement
- Relocation expenses

Applications are accepted on a rolling basis with two annual review dates: **January 15** | **June 15**

VISIT: www.zintellect.com/Posting/Details/6033 • **EMAIL:** DOE-RPP@orau.org
energy.gov/solar-office

AAAS Science and Technology Policy Fellowship

- Opportunity for scientists and engineers to learn first-hand about government and apply their knowledge and analytical skills to federal policymaking
- Yearlong assignments across the executive, legislative and judicial branches of the federal government
- Students who have completed their PhD by the application deadline are eligible to apply
- Next application deadline: November 1



Science & Technology
Policy Fellowships

Interested in Joining Us?



Join our team. Design national R&D strategies across:



Photovoltaics



Systems Integration



Manufacturing and
Competitiveness



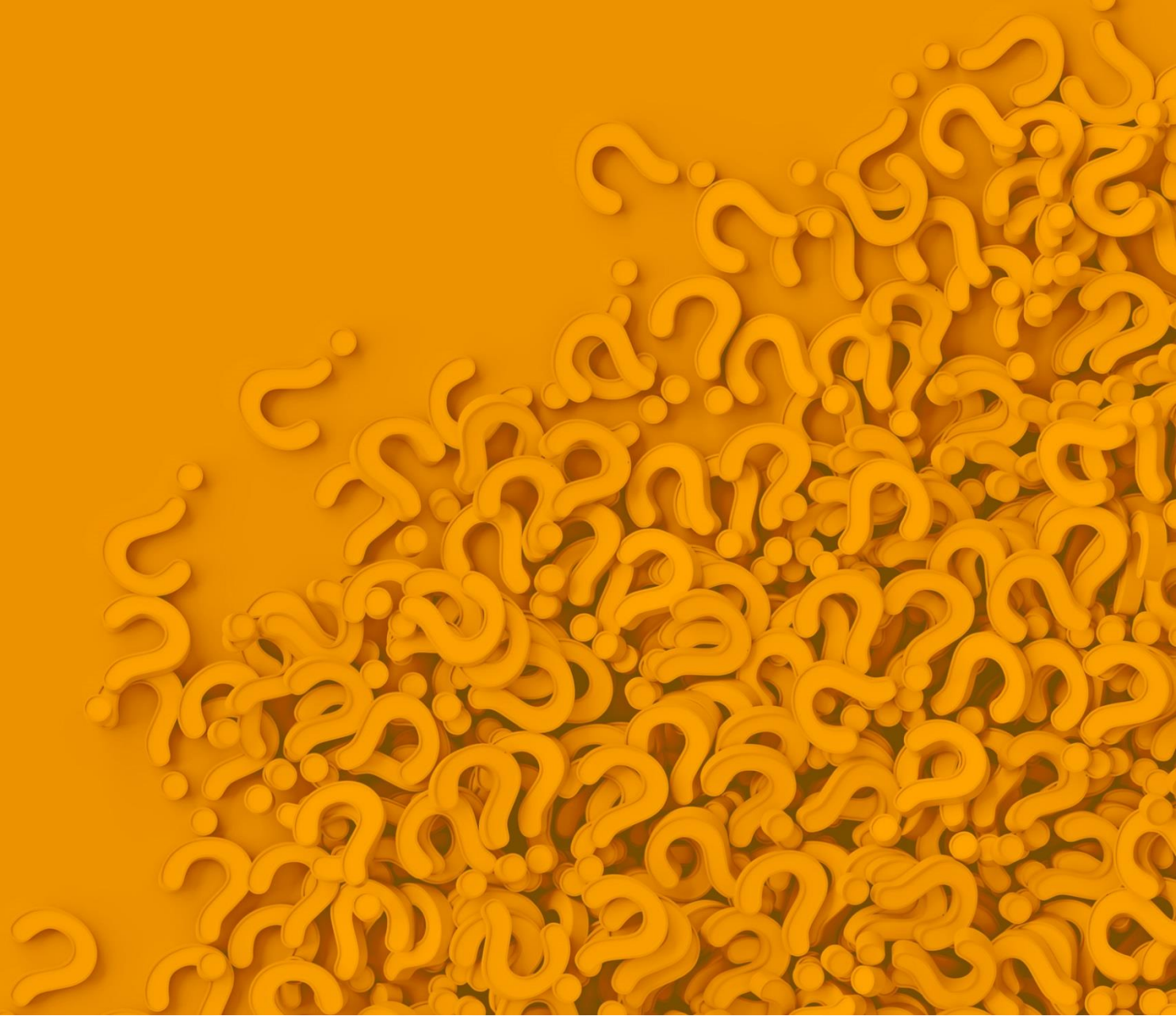
Concentrating Solar-
Thermal Power



Strategic Analysis and
Institutional Support

energy.gov/seto-jobs

Q&A



Keeping Connected

- Email questions to solar@ee.doe.gov
- Upcoming events on energy.gov/seto-events
- Read [how to apply for a funding opportunity](#)
- Take our feedback survey (QR code or bit.ly/HBCU-Feedback)



SIGN UP NOW:
energy.gov/solar-newsletter